COMPARATIVE PHYSIOLOGY OF TROGLOBITIC AND EPIGEAN ARTHROPODS FROM HAWAII VOLCANOES NATIONAL PARK[1]

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Hawaii Volcanoes National Park offers a unique opportunity to study the biology of organismic cave adaptation because extensive lava tube cave ecosystems with an assemblage of troglobitic species occur within the boundaries of this natural reserve. This paper reports the results of a preliminary laboratory investigation concerning the comparative physiology of metabolism and water balance of troglobitic and epigean crickets and spiders collected within the Park.

Comparative metabolic rates (oxygen consumption) of cave-adapted (Caconemobius varius) and lava flow (Coconemobius sp.) crickets were measured during morning and evening hours (constant dark conditions; water saturated atmosphere; 23°C) with a Gilson Differential Respirometer. In both morning and evening hours the epigean cricket consumed a significantly ($P < 0.05$) greater amount of oxygen than did the troglobite [epigean (night) = 518 ± 75 (10) $\mu l O_2 \cdot g/hr$; troglobite (night) = 374 ± 32 (10); epigean (morning) = 306 ± 44 (10); troglobite (morning) = 209 ± 29 (6); mean ± 1 SEM (sample size)]. In addition, both species had significantly ($P < 0.05$) higher metabolic rates at night than in the day.

Comparative rates of water loss in troglobitic and epigean crickets and spiders were measured individually at 19°C in glass desiccators containing saturated salt solutions or distilled water which were placed in a temperature-programmed incubator. Weight loss following a 5-hour incubation at 0, 50, 75, or 90% R.H. was considered equivalent to net water loss. Both lava tube crickets (C. varius) and spiders (Lycosa howarthi) lost between 2-10 times more body water at most relative humidities than did

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[1] Abstract

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the epigean animals (C. fori, C. sp., and L. sp.). Permeability values ($\mu g/cm^{-2}/hr/mmHg$) for total water loss in these animals at 0% R.H. were: C. varius = 29.56 ± 4.22; C. fori = 15.28 ± 3.25; C. sp. = 15.47 ± 1.28; L. howarthi = 33.38 ± 5.35; and L. sp. = 3.12 ± 1.08.

Epicuticular lipids from L. howarthi and L. sp. were measured using thin-layer and gas chromatography following their extraction from the animals in non-polar solvents. Values for total lipid, total hydrocarbons, and total non-hydrocarbons from these animals were: L. howarthi = 0.63, 0.07, 0.55 mg/g/spider and L. sp. = 1.61, 0.18, 1.43 mg/g/spider. Among the hydrocarbons present, the cave animal had 64.9 and 35.1% as N-alkanes (straight chains) and branched alkanes, respectively, while the corresponding values for the epigean spider were 26.1 and 73.9%, respectively. Branching epicuticular lipids are generally associated with arthropods from xeric habitats, while straight chain lipids are found in mesic species.